Asian Economic and Financial Review
ISSN(e): 2222-6737/ISSN(p): 2305-2147

journal homepage: http://www.aessweb.com/journals/5002

THE IMPACT OF MACROECONOMIC FACTORS ON THE HERDING BEHAVIOUR OF INVESTORS

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ABSTRACT

This study uses the linear model based on the notion of cross-sectional standard deviation (CSSD) by Christie and Huang (1995) and nonlinear model based on cross-sectional absolute deviation (CSAD) proposed by Chang et al. (2000) to provide evidence for the existence of herding behaviour by investors in Taiwan during the period January 4, 2000 to December 28, 2012. We examine whether returns, volume, volatility, S&P500, volatility index (VX) and financial crisis influence the cross-sectional dispersion of the stock market. Macroeconomics is an important factor for the stock market; thus, this paper further examines how exchange rate and interest rate affect herding effect. We investigate asymmetric herding behaviour under different market conditions. Finally, this paper uses quantile regression to estimate the herding effect. First, we find evidence of herding behaviour based on the CSAD model. Second, the cross-sectional return dispersion in Taiwan exhibits a positive (negative) relationship with the US market and financial crisis (interest rate). Third, we find asymmetric herding behaviour under different conditions for market returns, trading volume, VX and interest rate. Fourth, Taiwan's investors consistently exhibit herding behaviour in different quantiles during different market conditions.

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Keywords: CSSD model, CSAD model, Herding behaviour, Asymmetric herding behaviour, Quantile regression, Macroeconomic factors.

Contribution/ Originality

This study provides in-depth insights into herding behaviour. The cross-sectional return dispersion exhibits different relationships with macroeconomic factors. The asymmetric herding behaviour under different conditions for market returns, trading volume, VX and interest rate. The

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DOI: 10.18488/journal.aefr/2015.5.2/102.2.295.304
ISSN(e): 2222-6737/ISSN(p): 2305-2147
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investor exhibits asymmetric herding behaviour at various market conditions in different quantile levels.

1. INTRODUCTION

Herding, investors deciding to imitate others or the market consensus rather than follow their own beliefs and information, has attracted the attention of academic researchers. Herding may cause prices to deviate from their fundamental value and present profitable trading opportunities. Christie and Huang (1995) measure herding by using a cross-sectional dispersion of the asset returns approach. Although cross-sectional standard deviation (CSSD) is a quite intuitive measure of the cross-sectional return dispersion, it is considerably affected by the existence of outliers. Therefore, Chang *et al.* (2000) alternatively propose the cross-sectional absolute deviation (CSAD) of stock returns around the market portfolio return as a more appropriate measure. In this paper, we employ two major testing methodologies. We employ linear and nonlinear models based on the return dispersions among individual firms in order to provide further insight into the driving forces behind herding behaviour.

In the past, many papers of herding behaviour focused on the cross-sectional correlation dispersion in the response of stock returns to different market conditions. First, since the US market still plays a significant role in financial markets, the return dispersions of non-US markets exhibit a positive relationship on the US (Economou *et al.*, 2011; Philippas *et al.*, 2013).[1] Second, when the market experiences large price swings such as a financial crisis, this may cause the return dispersion to either decrease or increase (Claessens *et al.*, 2010; Economou *et al.*, 2011; Philippas *et al.*, 2013).[2] Third, the volatility index (VX) has also been suggested as a good proxy; this has been termed investors' fear gauge and it is used by traders as a sentiment indicator (Chiang and Zheng, 2010; Philippas *et al.*, 2013).[3] Besides the above factors, we also think that macroeconomics is an important factor for stock markets. With increasing international diversification, international investment and international trade are becoming important; thus, the trade of interest rates and exchange rates is getting more attention gradually (Flannery *et al.*, 1997; Aydemir and Demirhan, 2009; Tsai, 2012; Philippas *et al.*, 2013).[4] In the past, studies seldom used various market conditions together to discuss this issue. In this paper, we use the US stock market, financial crisis, VX, interest rate and exchange rate to examine whether these factors affect the cross-sectional dispersion of stock market returns in the Taiwan market.

Most previous studies propose that more pronounced herding behaviour occurs during different market conditions. Tan *et al.* (2008) find that herding behaviour is stronger in high volatility, positive market returns and high trading volume in the Chinese stock market. Economou *et al.* (2011) find that Greek and Spanish as well as Portuguese and Spanish entities have asymmetric herding behaviour in trading volume, while Italian and Spanish ones have asymmetric volatility. Philippas *et al.* (2013) find that herding behaviour in negative market returns is stronger than up market returns. Recent empirical research highlights herding behaviour during different market conditions. Therefore, we use market returns, volume, volatility, US stock market, financial crisis, VX, interest rate and exchange rate to examine whether there are asymmetric herding behaviours under different market conditions.

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[1] Economou, Kostakis and Philippas (2011). find that the cross-sectional return dispersion in four south European markets exhibits a positive relationship on the S&P500. Philippas, Economou, Babalos and Kostakis (2013). find that the cross-sectional return dispersion in REIT exhibits a positive relationship on the S&P500.

[2] Claessens, Dell'Ariccia, Lgan and Laeven (2010). show that the collapse of the US sub-prime mortgage market in the summer of 2007 and the ensuing Lehman failure in September 2008 triggered a financial crisis in the United States that was considered to be the most serious global crisis since the Great Depression. Economou, Kostakis and Philippas (2011). find that a crisis will not decrease the cross-sectional return dispersion. Philippas, Economou, Babalos and Kostakis (2013). show that a crisis may not decrease the cross-sectional return dispersion.

[3] Philippas, Economou, Babalos and Kostakis (2013). use CFE-VIX to examine whether the herding effects in REITs are associated with investors' perceptions of uncertainty regarding future market conditions.

[4] Macroeconomics is also an important factor for stock markets. Flannery, Hameed and Harjes (1997). find that interest rate risk is priced for overall US stock portfolios. Philippas, Economou, Babalos and Kostakis (2013). find that the three-month LIBOR leads to reductions in the cross-sectionality of returns. Aydemir and Demirhan (2009). show that cross-market return correlations, the gradual abolishment of capital inflow barriers and foreign exchange restrictions, and flexible exchange rate arrangements in emerging and transition counties as well as in stock and foreign exchange markets have become interdependent. Tsai (2012). mentions that the relationship between the stock price index and exchange rate are both important in determining the development of a country.

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This paper further examines asymmetric herding behaviours under different market conditions with different quantile distributions.[5] Quantile regression estimates the potential differential effect of a covariate on various quantiles in the conditional distribution. Chiang *et al.* (2010) find that herding behaviour is more prevalent at the quantile distributions of the return dispersions from low to median quantiles. Gebka and Wohar (2013) find that herding behaviour is not significant on an international level, even where it is most likely to be observed at the 0.1 quantile of dispersion distribution. However, they only use low quantiles to discuss asymmetric herding behaviours under different market returns. We further examine different quantiles to analyse herding effects during different market conditions. Our empirical study significantly contributes to this field of research and bridges a gap in the literature on how different market conditions affect the cross-sectional return dispersion by examining the herding effect during different market conditions. We also use quantile regression to discuss the herding effect during different market conditions. We find the following respects. First, there is herding behaviour in the Taiwan stock market. Second, the cross-sectional return dispersion in the Taiwan stock market was affected by the US market and interest rate. Third, in asymmetric herding behaviour testing, we find that negative market returns, high trading volume, high VX and low interest rate have stronger herding behaviour. Fourth, we find that each market condition has asymmetric herding behaviour at different quantile levels.

2. DATA AND METHODOLOGY

2.1. Data

The dataset used in this study contains daily returns for 810 Taiwanese stocks traded on the Taiwan stock exchange over the January 4, 2000 to December 28, 2012 period. Stock data, S&P500, interest rate and exchange rate were obtained from the Taiwan Economic Journal database. VX was downloaded from Yahoo Finance. Returns were calculated as $R_{i,t} = 100 \times \left(\log(P_{i,t}) - \log(P_{i,t-1})\right)$, where $P_{i,t}$ and $P_{i,t-1}$ are the price of observed stock i at time t and t-1.

2.2. Methodology

2.2.1. CSSD Model

This study first uses the return dispersions of CSSD developed by Christie and Huang (1995) measured by the return dispersion, which is defined as follows:[6]

$$CSSD_t = \sqrt{\frac{\sum_{i=1}^{N}(R_{i,t}-R_{m,t})^2}{N-1}} \quad (1)$$

where $R_{i,t}$ is the observed stock return of i at time t, $R_{m,t}$ is the cross-sectional average return of N returns in the market portfolio for day t and N is the number of assets in the portfolio.[7] This methodology also suggests that the presence of herding behaviour is most likely to occur during periods of extreme market movements, as they would most likely tend to go with the market consensus during such periods. The benchmark model to test for the existence of herding is given by the following regression:

$$CSSD_t = \alpha + \beta_L D_t^L + \beta_U D_t^U + \varepsilon_t \quad (2)$$

where $D_t^L = 1$ if the return on the aggregate market portfolio on day t lies in the extreme lower tail of the return distribution and 0 otherwise, and $D_t^U = 1$ if the return on the aggregate market portfolio on day t lies in the extreme upper tail of the return distribution and 0 otherwise. If herding occurs, then $CSSD_t$ will be small during periods of market stress, with statistically significant negative values for β_L and β_U.

[5] Quantile regression gives a more comprehensive picture of the effect of the independent variables on the dependent variable. Instead of estimating the model with average effects using the OLS linear model, quantile regression produces different effects along the distribution (quantiles) of the dependent variable. Advantages of quantile regression: OLS can be inefficient if the errors are highly non-normal, while quantile regression is more robust to non-normal errors and outliers, and quantile regression provides a richer characterisation of the data, allowing us to consider the impact of a covariate on the entire distribution of the independent variable, not merely its conditional mean.

[6] Christie and Huang (1995). propose that during periods of extreme market movements, individual investors tend to imitate others rather than follow their own beliefs and information, because they are more likely to follow the market consensus during such periods than rational asset-pricing models during normal periods.

[7] We follow the existing literature and use the equal-weighted average of stock returns on this particular day as a proxy for $R_{m,t}$.

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2.2.2. CSAD Model

Chang *et al.* (2000) argue that the CSSD model requires defining what is meant by market stress. Moreover, if herding occurs during periods of market stress, then a nonlinear relationship will also exist. This nonlinear relationship of CSAD can be modelled as follows:

$$\mathrm{CSAD_t} = \frac{1}{N}\sum_{i=1}^{N}\left|R_{i,t} - R_{m,t}\right| \quad (3)$$

where the definitions of $R_{m,t}$ and $R_{i,t}$ are the same as for the CSSD indicator. In the following section, we present the nonlinear framework of Chang *et al.* (2000) to test for herding behaviour. This is given by

$$\mathrm{CSAD_t} = \alpha + \gamma_1\left|R_{m,t}\right| + \gamma_2 R_{m,t}^2 + \varepsilon_t \quad (4)$$

where $\mathrm{CSAD_t}$ is a measure of the return dispersion, and $\left|R_{m,t}\right|$ and $R_{m,t}^2$ are the values of an equally weighted and squared return of all in the market portfolio on day t.

2.3. Impact of Different Market Conditions on the Return Dispersion

We examine how S&P500 market returns, VX, financial crises, exchange rate and interest rate affect the cross-sectional dispersion of stock market returns. In the following model:[8]

$$\mathrm{CSAD_t} = \alpha + \gamma_1\left|R_{m,t}\right| + \gamma_2 R_{m,t}^2 + \gamma_3 (X_t)^2 + \varepsilon_t \quad (5)$$

$$\mathrm{CSAD_t} = \alpha + \gamma_1\left|R_{m,t}\right| + \gamma_2 R_{m,t}^2 + \gamma_3 \mathrm{Crisis} \times R_{m,t}^2 + \varepsilon_t \quad (6)$$

where X_t=($R_{us,t-1}$, $R_{VX,t-1}$, $R_{I,t}$ and $R_{e,t}$), while $R_{us,t-1}$ and $R_{VX,t-1}$ are S&P500 market returns and the change in VX at day t-1. $R_{I,t}$ and $R_{e,t}$ are the interest rate and the change in exchange rate at day t. Crisis=(D^l and D^s) takes the value 1 on trading days during the crisis period and 0 otherwise.[9]

2.4. Asymmetric Herding Behaviour under Market Conditions

Besides the market condition variables (return, volume and volatility) used in Tan *et al.* (2008), we also use S&P500 market returns, VX, interest rate and the change in exchange rate to examine asymmetric herding behaviour under different market conditions. The asymmetric herding model is represented as follows:

$$\mathrm{CSAD_t} = \alpha + \gamma_1 D\left|R_{m,t}\right| + \gamma_2(1-D)\left|R_{m,t}\right| + \gamma_3 D R_{m,t}^2 + \gamma_4 (1-D) R_{m,t}^2 + \varepsilon_t \quad (7)$$

where $D = \left(D^m, D^V, D^{Vol}, D^{US}, D^{VX}, D^I \text{ and } D^e\right)$. D^m takes the value 1 for positive market returns conditions and 0 otherwise, while D^V, D^{Vol}, D^{US}, D^{VX}, D^I and D^e[10] take the value 1 if it is higher than the previous *30-day moving average* and 0 otherwise.[11] If herding effects prevail, γ_3<0 or γ_4<0, we expect the effects to be more pronounced at negative market return, negative S&P500 market return, lower interest rate and higher change in exchange rate, and this $\gamma_3 < \gamma_4$. If herding effects prevail, γ_3<0 or γ_4<0, we expect them to be more pronounced during days with high trading volume, market volatility, VX and a change in exchange rate, and thus $\gamma_3 > \gamma_4$.

2.5. Quantile Regression Analysis

We employ the method of quantile regression to examine the herding effect under different market conditions.

[12] Suppose the conditional mean of CSAD is $\mu(Z) = Z'\beta$, using the OLS approach to estimate the mean.

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[8] Demirer, Kutan and Chen (2010). think that the linear model (CSSD) fails to capture the co-movement between individual asset returns and aggregate market returns, which might lead to incorrect test results.

[9] Following Philippas, Economou, Babalos and Kostakis (2013)., we apply the regression with a dummy variable D. Firstly, we use the period from August 2007 to December 2008, D^l. Alternatively, we utilise a much narrower definition, characterising as the crisis period the collapse of Lehman Brothers, the period from September to October 2008, D^s.

[10] We have added the lagged squared US market return and VX.

[11] As high on day t is greater than the previous 30-day moving average.

[12] Quantile regression differs from the OLS approach as rather than giving the expected value of the dependent variable for any fixed value of the independent variable, it instead reports a reselected quantile of the distribution.

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$\min_{\beta \in R^P} \sum_{t=1}^{n} \rho_\tau(E_t - X'_t\beta)$
(8)

where $X_t\hat{\beta}$ is an approximation of the conditional quantile of R to minimise the following equation:

$$\min_{\hat{\beta}} \left[\tau \sum_{E_t \geq X_t\hat{\beta}} |E_t - X_t\hat{\beta}| + (1-\tau) \sum_{E_t < X_t\hat{\beta}} |E_t - X_t\hat{\beta}|\right] \quad (9)$$

Solving Eq. (8) will give the estimation in different quantiles. We let τ stand for the quantile variable. The function can be written as

$$Q(\tau|Z_t) = \gamma_{0,\tau} + \gamma_{1,\tau}D|R_{mt}| + \gamma_{2,\tau}(1-D)|R_{mt}| + \gamma_{3,\tau}D(R_{m,t})^2 + \gamma_{4,\tau}(1-D)(R_{m,t})^2 \quad (10)$$

When τ is close to zero (one), this characterises the behaviour of R at the left (right) tail of the conditional distribution.

3. EMPIRICAL RESULTS

3.1. Descriptive Statistics

Table 1 provides a summary of the statistics. We find that the average Taiwan stock return is 0.0076 and the average S&P500 return is -0.0220. The average interest rate in this period is 1.6427%, suggesting that saving money in banks is better than investing in the stock market. The average VX is 21.992. The average R_E is -0.0017, which means Taiwan's exchange rate is appreciating in this period. According to the Jarque–Bera test, we can reject the null hypothesis of normality.

Table-1. Descriptive statistics

Variables	Mean	Std. Dev.	Skewness	Kurtosis	Jarque–Bera
$R_{m,t}$	0.0076	1.4905	-0.5096	5.2779	843.8378***
CSSD	2.3292	0.5140	0.8708	4.3562	660.2704***
CSAD	1.7169	0.4724	0.8187	3.5333	401.8054***
Volume	0.0248	0.2459	3.3046	45.1037	246122.9***
Volatility	2.165	1.7831	1.3923	2.3085	1757.006***
R_{us}	-0.0220	2.2204	-28.3848	1281.2030	7634.896***
VX	21.9920	9.1998	1.9319	9.0433	6658.5470***
R_I	1.6427	1.1316	1.2651	3.7127	936.2547***
R_E	-0.0017	0.3006	0.2442	17.4181	28191.71***

Notes: *, ** and *** represent statistical significance at the 10%, 5% and 1% levels. $R_{m,t}$ is the cross-sectional average return of N returns in the market portfolio, Volume and Volatility are Taiwan stock index, log trading volume and volatility. CSSD is the cross-section standard deviation. CSAD is the cross-section absolute deviation. R_{us} and VX are the returns of S&P500 and the VX of S&P500. R_I and R_E are Taiwan's interest rate and the change in exchange rate.

3.2. Estimated Results for Herding Behaviour

Table 2 shows the estimates of herding behaviour in the Taiwan stock market. We use equations (2) and (4) to estimate whether Taiwan has existing herding behaviour. We do not find any evidence of herding by using the CSSD model under 5% and 10% extreme returns. One of the challenges associated with the approach described above is that it requires the definition of extreme returns. The CSSD model captures herding only during periods of extremely large variation. Demirer *et al.* (2010) find that the linear model, that is the CSSD model, fails to capture the price co-movement between the return dispersion and market returns, which might lead to incorrect test results. Thus, we use the CSAD model to examine whether Taiwan has existing herding behaviour. γ_1 is positive and statistically significant, consistent with standard asset pricing models. We find that γ_2 is significantly negative, which means that Taiwan has existing herding behaviour. These findings support Chang *et al.* (2000) that the average market return becomes large in absolute terms and that the cross-sectional return dispersion increases at a decreasing rate.

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Table-2. Estimates of herding behaviour in the Taiwan stock market

Models	α	γ_1	γ_2
CSSD (5%)	2.2977***	0.1991***	0.4362***
	(0.0093)	(0.0407)	(0.0408)
CSSD (10%)	2.2585***	0.2821***	0.4266***
	(0.0097)	(0.0290)	(0.0291)
CSAD	1.3882***	0.4514***	-0.0680***
	(0.0134)	(0.0193)	(0.0044)

Notes: This table reports the herding behaviour in the Taiwan stock market and the regression models are CSSD and CSAD. The number in the parentheses is standard deviation. $CSSD_t = \alpha + \gamma_1 D_t^U + \gamma_2 D_t^L + \varepsilon_t$, $R_{i,t}$ is the observed stock return of i at time t, $R_{m,t}$ is the cross-sectional average return of N returns in the market portfolio for day t, and N is the number of assets in the portfolio. $CSAD_t = \alpha + \gamma_1 |R_{m,t}| + \gamma_2 |R_{m,t}|^2 + \varepsilon_t$, same as for the CSSD indicator. *, ** and *** represent statistical significance at the 10%, 5% and 1% levels.

3.3. Impact of Different Market Conditions on the Cross-Sectional Return Dispersion

Table 3 reports the result of the impact of different market conditions on herding behaviour. We find all the γ_2 are significantly negative. First, we add the lagged squared returns on the S&P500, and we find evidence that the cross-sectional return dispersion in the Taiwan stock market exhibits a positive relationship with the lagged squared return on the S&P500. This result is the same as those of Economou *et al.* (2011) and Philippas *et al.* (2013). Second, VX does not influence Taiwan's cross-sectional return dispersion. Third, the results show that the coefficient of interest rate is negative and highly significant to Taiwan's cross-sectional return dispersion; however, exchange rate does not influence Taiwan's cross-sectional return dispersion. When the interest rate goes up, investors may think it is bad news for the stock market and this may cause the cross-sectional return dispersion to reduce. Fourth, we test whether herding effects are stronger during periods of financial crises. The broad one refers to the entire period (August 2007–December 2008), while the narrow one refers to the period around the collapse of Lehman Brothers (September 2008–October 2008). Overall, there is no evidence that the cross-sectional return dispersion decreased during this crisis period. This result is the same as those of Economou *et al.* (2011) for four south European markets and Philippas *et al.* (2013) for REIT markets.

Table-3. Impact of different market conditions on the return dispersion

Market Conditions	α	γ_1	γ_2	γ_3
$R_{us,t-1}$	1.3878***	0.4464***	-0.0681***	0.0063***
	(0.0135)	(0.0191)	(0.0044)	(0.0015)
VX_{t-1}	1.3782***	0.4589***	-0.0696***	0.0014
	(0.0137)	(0.0201)	(0.0047)	(0.0059)
$R_{I,t}$	1.3885***	0.4497***	-0.0678***	-0.8069**
	(0.0134)	(0.0193)	(0.0044)	(0.3787)
$R_{E,t}$	1.3882***	0.451***	-0.0679***	0.0023
	(0.0134)	(0.0193)	(0.0045)	(0.0283)
$D^l(R_{mt})^2$	1.3879***	0.4526***	-0.0688***	0.0021
	(0.0134)	(0.0195)	(0.0048)	(0.0028)
$D^s(R_{mt})^2$	1.3879***	0.4521***	-0.0683***	0.0014
	(0.0135)	(0.0198)	(0.0047)	(0.0040)

Notes: This table reports the estimated coefficients of the regressions model: $CSAD_t = \alpha + \gamma_1|R_{mt}| + \gamma_2|R_{mt}|^2 + \gamma_3(X_t)^2 + \varepsilon_t$, where X_t=($R_{us,t-1}$, $R_{VX,t-1}$, $R_{I,t}$ and $R_{E,t}$), $R_{us,t-1}$ and VX_{t-1} are the returns of S&P500 and the VX of S&P500 at day t-1. $R_{I,t}$ and $R_{E,t}$ are the interest rate and the change in exchange rate at day t. Crisis=(D^l and D^s), D^l the period August 2007 – December 2008 and D^s the period September 2008 – October 2008 take the value 1 on the trading days during the crisis period and 0 otherwise. *, ** and *** represent statistical significance at the 10%, 5% and 1% levels. The numbers in the parentheses are standard deviation.

3.4. Estimated Results for Asymmetric Herding Behaviour under Different Market Conditions

Table 4 shows asymmetric herding behaviour according to different market conditions, which

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are classified into two sectors (i.e. high or low levels). We find all the estimated γ_3 and γ_4 coefficients are significantly negative. For the null hypothesis, γ_3-γ_4=0, we find that D^m and D^I (D^V and D^{VX}) have significantly positive (negative) values, implying there is asymmetric herding behaviour and that herding behaviour in low (high) level market conditions has more influence than in high (low) level market conditions.

Table-4. Estimates of asymmetric herding behaviour

Market Conditions	α	γ_1	γ_2	γ_3	γ_4	γ_3-γ_4	Predicted sign of γ_3-γ_4
D^m	1.3777***	0.3822***	0.5038***	-0.0541***	-0.0769***	0.0227***	+
	(0.0138)	(0.0208)	(0.0245)	(0.0049)	(0.0066)	[0.0012]	
D^V	1.3887***	0.5553***	0.3538***	-0.0904***	-0.0485***	-0.0419***	-
	(0.0134)	(0.0210)	(0.0242)	(0.0047)	(0.0066)	[0.000]	
D^{Vol}	1.3886***	0.4488***	0.4521***	-0.0690***	-0.0667***	-0.0024	-
	(0.0133)	(0.0232)	(0.0215)	(0.0059)	(0.0051)	[0.7213]	
D^{US}	1.3883***	0.4389***	0.4635***	-0.0660***	-0.0698***	0.0038	+
	(0.0134)	(0.0213)	(0.0242)	(0.0050)	(0.0063)	[0.5794]	
D^{VX}	1.4102***	0.5542***	0.3158***	-0.0929***	-0.0386***	-0.0543**	-
	(0.0144)	(0.0212)	(0.0296)	(0.0045)	(0.0093)	[0.000]	
D^I	1.3894***	0.4470***	0.7233***	-0.0670***	-0.1321***	0.0651***	+
	(0.0134)	(0.0195)	(0.0835)	(0.0045)	(0.0184)	[0.0005]	
D^E	1.3887***	0.4604***	0.4379***	-0.0709***	-0.0637***	-0.0072	-
	(0.0135)	(0.0206)	(0.0258)	(0.0047)	(0.0070)	[0.3180]	

Notes: The regressions model: $CSAD_t = \alpha + \gamma_1 D|R_{mt}| + \gamma_2(1-D)|R_{mt}| + \gamma_3 D(R_{m,t})^2 + \gamma_4(1-D)(R_{m,t})^2 + \varepsilon_t$, where $D = (D^m, D^V, D^{Vol}, D^{VX}, D^{US}, D^I$ and $D^E)$ and D^m (D^{US}, D^{VX}, D^I and D^E) takes the value 1 on the positive market returns (greater than the full sample median value of S&P500, VX, interest and change in exchange rate) and 0 otherwise. D^V and D^{Vol} take the value 1 as compared to greater than a 30-day moving average volume and volatility and the value 0 otherwise. *, ** and *** represent statistical significance at the 10%, 5% and 1% levels. The numbers in the parentheses are standard deviation and the numbers in the square brackets are t-statistics.

Based on the above information we make three findings. First, the herding effect for the Taiwan stock market is stronger in a down market than in an up market, while the herding effect during high trading volume is stronger than that in low trading volume. Second, the herding effect during low interest rate is stronger than that in high interest rate, indicating investors will choose to invest in stock rather put money in banks when the interest rate is low. Third, the herding effect during high VX is stronger than that during low VX. VX has been termed investors' fear gauge. Increases in implied VX are actually negatively related to Taiwan's stock return. High VX means investors are panicking and this might force them to choose to imitate other people who have more information.

3.5. Asymmetric Herding Behaviour under Different Market Conditions by Quantile Regression

Table 5 presents the estimated results for asymmetric herding behaviour under different market conditions by quantile regression in the Taiwan stock market. In the OLS model, we find that all the conditions in γ_3 and γ_4 are negative and statistically significant at the 1% level. If we want more information about the herding effect, then we use quantile regression. Here, we find both coefficients on γ_3 and γ_4 are negative and statistically significant at the 1% level in all quantiles (τ=0.05 to 0.95) except low volume in the 30th to 95th quantiles (τ=0.3 to 0.95), low volatility, S&P500 in a down market, VX in the 80th and 95th quantiles and low interest in the 50th to 95th quantiles ($\tau = 0.5$ and 0.95), which have positive γ_4.

This paper examines asymmetric herding behaviour during different market conditions from different quantiles; thus, we test H0:γ_3-γ_4, and find most of the statistics of H0:γ_3-γ_4 on market return, volume, S&P market return, VX and interest rate are significant, implying there is asymmetric herding behaviour in various market conditions during different quantiles.

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First, we find that the asymmetric herding effect in $R_{m,t}$ is more prevalent in lower than in high quantiles $\tau = 0.2$ to 0.95. Second, the results for volume show a significant asymmetric herding effect, except the low quantile $\tau = 0.05$. Third, the results for volatility show a significant herding effect during the high quantiles $\tau = 0.8$ to 0.9. Fourth, the results for S&P500 returns show a significant asymmetric herding effect during all quantiles; moreover, down (up) market conditions show a stronger herding effect than up (down) market conditions at low (median to high) quantiles $\tau = 0.05$ to 0.2 ($\tau = 0.3$ to 0.95). Fifth, the results of VX show a significant asymmetric herding effect except for low quantiles $\tau = 0.05$ to 0.1. Sixth, the results of interest rate show a significant asymmetric herding effect during all quantiles, where low (high) interest rate shows a stronger herding effect than high (low) interest rate at low (median to high) quantiles $\tau = 0.05$ to 0.4 ($\tau = 0.5$ to 0.95). Seventh, the results of EX show a significant asymmetric herding effect at median quantiles $\tau = 0.3$ to 0.8. This study provides some insights into herding behaviour in the Taiwan stock market by using information from the quantile regression analysis.

Fig. 1 presents the quantile regression results for asymmetric herding behaviours (γ_3 and γ_4) under different market conditions in the Taiwan stock market. First, we show that herding behaviour when market returns are down is stronger than when the market is up for all quantiles. Second, high trading volume and volatility show steady and *persistent* herding behaviour in all quantiles. Third, high VX and the change in exchange rate have a *persistent increase on* herding behaviour from low to high quantiles. Fourth, low interest rate has stronger herding behaviour below median quantiles $\tau = 0.05$ to 0.5. Finally, S&P500 at negative market returns has stronger herding behaviour below 0.3 quantiles.

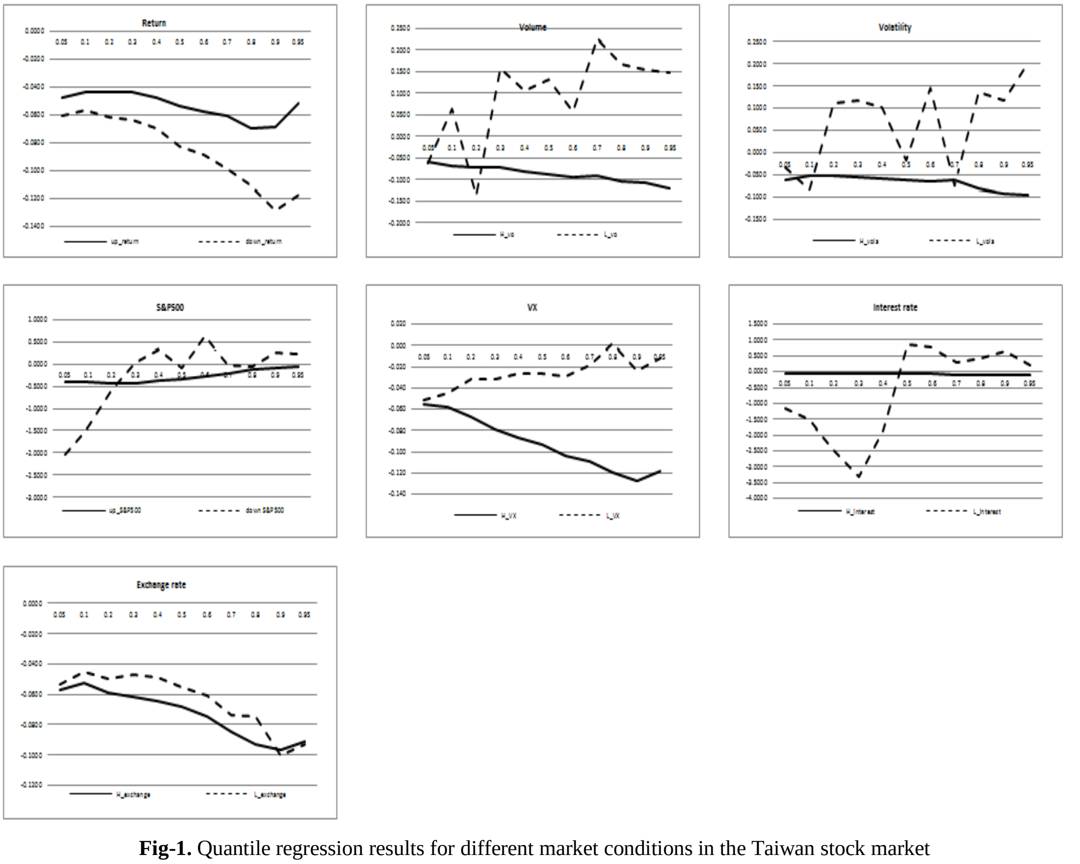

Fig-1. Quantile regression results for different market conditions in the Taiwan stock market

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Table-5. Quantile regression results for different market conditions

	market condition is R_{mt}			market condition is Volume			market condition is Volatility			market condition is S&P500		
	γ_3	γ_4	$H0{:}\gamma_3\text{-}\gamma_4$	γ_3	γ_4	$H0{:}\gamma_3\text{-}\gamma_4$	γ_3	γ_4	$H0{:}\gamma_3\text{-}\gamma_4$	γ_3	γ_4	$H0{:}\gamma_3\text{-}\gamma_4$
OLS	-0.0541***	-0.0769***	0.0227***	-0.0904***	-0.0485***	-0.0419***	-0.0690***	-0.0667***	-0.0024	-0.0660***	-0.0698***	0.0038
Q(0.05)	-0.0478***	-0.0613***	0.0135	-0.0579***	-0.0628***	0.0049	-0.0598***	-0.0316**	-0.0282	-0.4036***	-2.0501***	1.6465***
Q(0.1)	-0.0436***	-0.0570***	0.0135	-0.0673***	0.0645***	-0.1319***	-0.0501***	-0.0830***	0.0329	-0.3963***	-1.4223***	1.0259***
Q(0.2)	-0.0440***	-0.0622***	0.0182**	-0.0705***	-0.1375***	0.0670***	-0.0508***	0.1103***	-0.1610	-0.4306***	-0.5980***	0.1674***
Q(0.3)	-0.0436***	-0.0639***	0.0203***	-0.0728***	0.1576***	-0.2304***	-0.0544***	0.1172***	-0.1716	-0.4194***	0.0316*	-0.4509***
Q(0.4)	-0.0475***	-0.0697***	0.0222***	-0.0820***	0.1066***	-0.1887***	-0.0575***	0.1008***	-0.1582	-0.3652***	0.3510***	-0.7162***
Q(0.5)	-0.0542***	-0.0827***	0.0285***	-0.0891***	0.1327***	-0.2217***	-0.0616***	-0.0158**	-0.0458	-0.3400***	-0.0933***	-0.2467***
Q(0.6)	-0.0576***	-0.0886***	0.0311***	-0.0935***	0.0563***	-0.1498***	-0.0642***	0.1460***	-0.2101	-0.2823***	0.6494***	-0.9317***
Q(0.7)	-0.0606***	-0.0984***	0.0378***	-0.0912***	0.2284***	-0.3195***	-0.0612***	-0.0747***	0.0135	-0.2123***	-0.0381***	-0.1741***
Q(0.8)	-0.0702***	-0.1112***	0.0411***	-0.1022***	0.1688***	-0.2710***	-0.0804***	0.1373***	-0.2177**	-0.1180***	-0.0714***	-0.0466***
Q(0.9)	-0.0687***	-0.1288***	0.0601***	-0.1059***	0.1542***	-0.2601***	-0.0929***	0.1190***	-0.2118*	-0.0790***	0.2481***	-0.3271***
Q(0.95)	-0.0513***	-0.1176***	0.0663***	-0.1205***	0.1487***	-0.2692***	-0.0971***	0.2034***	-0.3005	-0.0513***	0.2296***	-0.2808***

	market condition is VX			market condition is Interest			market condition is EX		
	γ_3	γ_4	$H0{:}\gamma_3\text{-}\gamma_4$	γ_3	γ_4	$H0{:}\gamma_3\text{-}\gamma_4$	γ_3	γ_4	$H0{:}\gamma_3\text{-}\gamma_4$
OLS	-0.093***	-0.039***	-0.054***	-0.0670***	-0.1321***	0.0651***	-0.0709***	-0.0637***	-0.0072
Q(0.05)	-0.056***	-0.052***	-0.004	-0.0556***	-1.1712***	1.1156***	-0.0566***	-0.0532***	-0.0034
Q(0.1)	-0.058***	-0.045***	-0.013	-0.0564***	-1.5027***	1.4463***	-0.0520***	-0.0447***	-0.0073
Q(0.2)	-0.067***	-0.032***	-0.035***	-0.0587***	-2.4897***	2.4309***	-0.0590***	-0.0492***	-0.0098
Q(0.3)	-0.079***	-0.031***	-0.048***	-0.0610***	-3.3280***	3.2671***	-0.0613***	-0.0468***	-0.0145*
Q(0.4)	-0.087***	-0.026***	-0.061***	-0.0636***	-1.8661***	1.8025***	-0.0641***	-0.0488***	-0.0153**
Q(0.5)	-0.093***	-0.027***	-0.066***	-0.0738***	0.8605***	-0.9342***	-0.0679***	-0.0556***	-0.0124*
Q(0.6)	-0.104***	-0.029***	-0.075***	-0.0773***	0.7836***	-0.8608***	-0.0746***	-0.0605***	-0.0141**
Q(0.7)	-0.109***	-0.019***	-0.091***	-0.0831***	0.2876***	-0.3707***	-0.0842***	-0.0736***	-0.0106
Q(0.8)	-0.120***	0.002	-0.122***	-0.0939***	0.4229***	-0.5168***	-0.0930***	-0.0744***	-0.0186**
Q(0.9)	-0.127***	-0.024**	-0.104***	-0.0980***	0.6547***	-0.7527***	-0.0963***	-0.0998***	0.0035
Q(0.95)	-0.119***	-0.012	-0.107***	-0.0880***	0.2236***	-0.3116***	-0.0907***	-0.0929***	0.0023

Notes: 1. *, **and***represent statistical significance at the 10%, 5% and 1% levels. 2. Refer different market conditions R_{mt}, volume, volatility, S&P500, VX, interest rate and the change in exchange rate, the quantile regressions model: $Q(\tau|Z_t) = \gamma_{0,\tau} + \gamma_{1,\tau}D|R_{mt}| + \gamma_{2,\tau}(1-D)|R_{mt}| + \gamma_{3,\tau}D\left(R_{m,t}\right)^2 + \gamma_{4,\tau}(1-D)\left(R_{m,t}\right)^2$. where $D = \left(D^m,\ D^V, D^{Vol}, D^{VX}, D^{US}, D^I \text{ and } D^E\right)$ and D^m (D^{US}, D^{VX}, D^I and D^E) takes the value 1 on the positive market return (greater than the full sample median value of S&P500 returns, VX, interest and change in exchange rate) and 0 otherwise. D^V and D^{Vol} take the value 1 as compared to greater than a 30-day moving average volume and volatility and the value 0 otherwise.

4. CONCLUSIONS

This study provides evidence for the existence of herding effects in Taiwan during the period from January 4, 2000 to December 28, 2013. Macroeconomics is an important factor for stock markets; thus, we examine the impact of different market conditions on the cross-sectional return dispersion (return, volume, volatility, S&P500 returns, VX and financial crisis effect). Recent empirical research highlights the asymmetric characteristics of market conditions. We investigate asymmetric herding behaviour under different market conditions. Finally, the quantile method may be more efficient than the OLS method, and thus this paper uses quantile regression to estimate the herding effect.

First, we find evidence of herding behaviour based on the CSAD model. Second, the cross-sectional return dispersion in Taiwan exhibits a positive (negative) relationship with S&P500 market returns (interest rate). Third, we find asymmetric herding behaviour under different conditions for market returns, trading volume, VX and interest rate. Fourth, Taiwan's investors exhibit asymmetric herding behaviour at various market conditions in different quantile levels. Therefore, this paper provides in-depth insights into herding behaviour in Taiwan's stock market and refers to research on emerging markets as a reference.

5. ACKNOWLEDGEMENTS

We thank the Ministry of Science and Technology (MOST 102-2410-H-033-038 -MY2), R.O.C. for partial support.

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